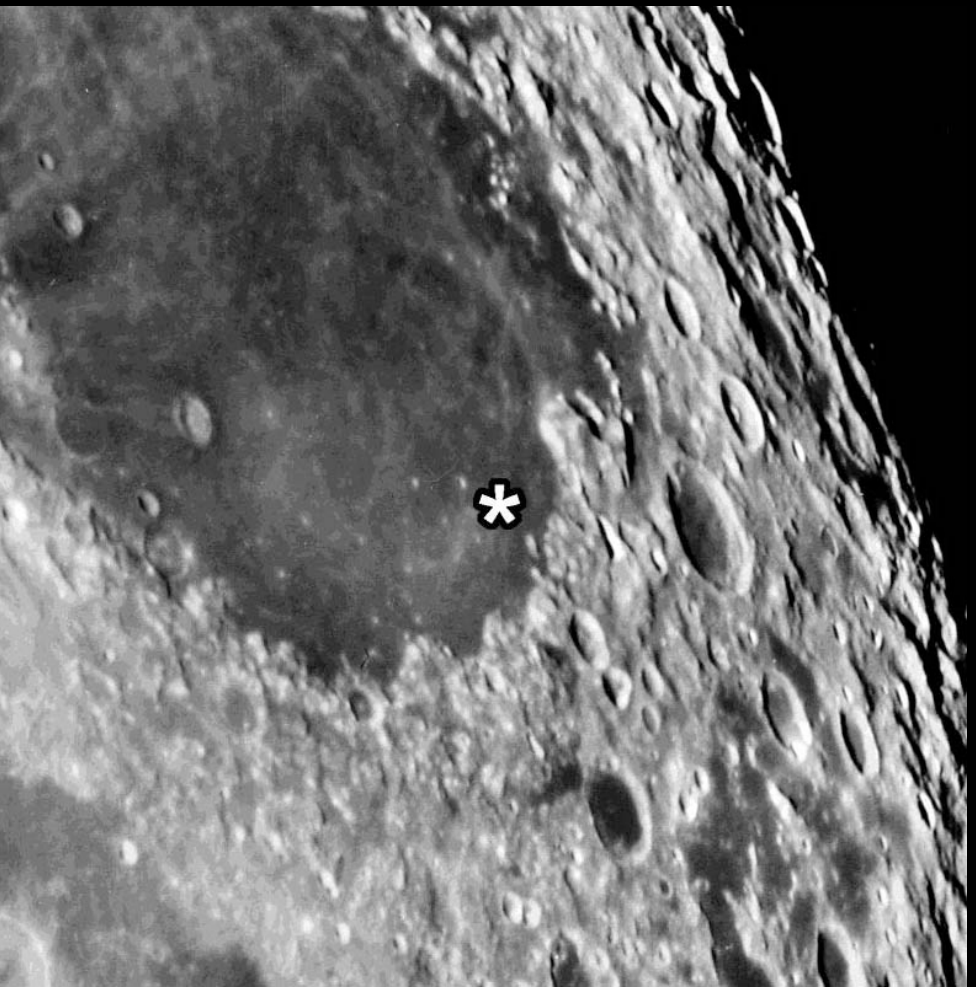
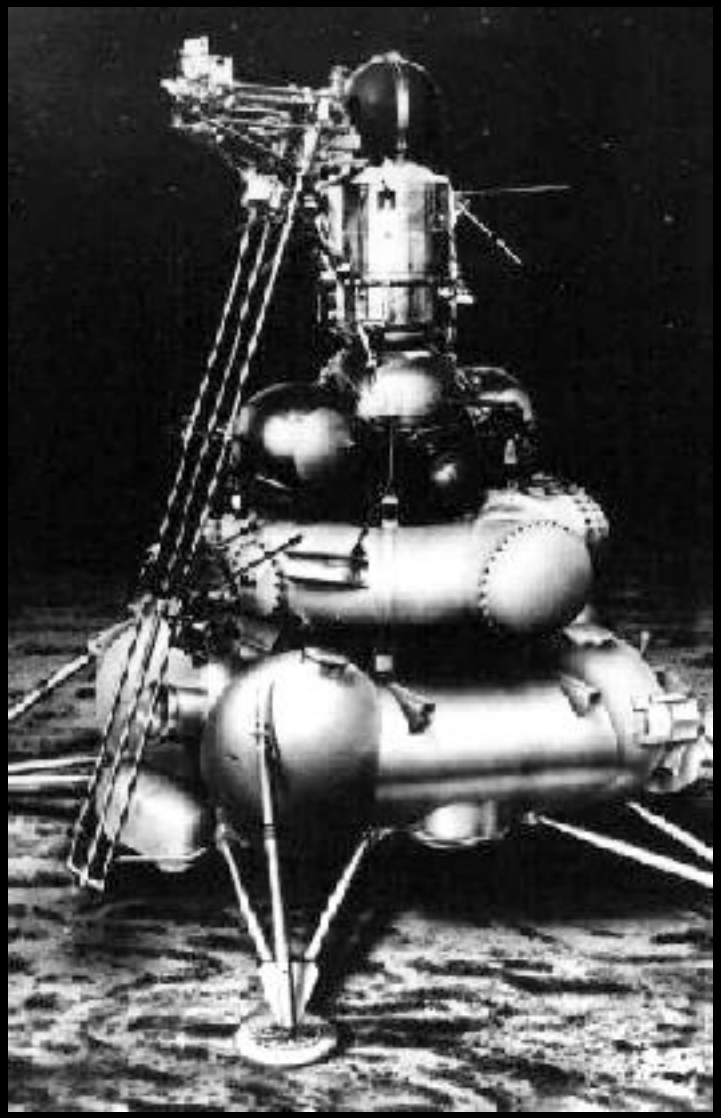
Geologic Analysis and Interpretation of New Spacecraft data for the Luna 24 Sampling Site



AT Basilevsky, CM Pieters,
D Dhingra, JW Head

Luna 24: 1976



Total height: 4.5 m

- In 1976 the Russian *autonomous* Luna24 spacecraft landed in Mare Crisium.
- It drilled into the surface and stored the contents in a return capsule.
- The samples were safely returned to Earth for analyses.

Lessons from incomplete data….

Lunar Black Spots and Nature of the Apollo 17 Landing Area[1]

CARLE PIETERS AND THOMAS B. MCCORD

Planetary Astronomy Laboratory, Department of Earth and Planetary Sciences
Massachusetts Institute of Technology, Cambridge, Massachusetts 02139

STANLEY ZISK

Haystack Observatory, Westford, Massachusetts 01886

JOHN B. ADAMS

West Indies Laboratory, Fairleigh Dickinson University
St. Croix, U.S. Virgin Islands 00820

A few small areas on the moon with extremely low albedo are shown also to have similar spectral reflectivity and radar backscatter characteristics. These lunar 'black spots' include the dark mantling material of the Apollo 17 landing site as well as areas of the Sulpicious Gallus formation. Excluded from the black spot group are the dark haloed craters of Alphonsus and the normal dark mare areas such as northern Mare Tranquillitatis. Earth-based radar and optical measurements indicate that these lunar black spots have rock-free surfaces with a very low proportion of crystalline material to amorphous material. The glassy soil is rich in iron and titanium, at least to the concentrations found at the Apollo 11 site. Crystalline pyroxene is present also. The data for the black spots are consistent with a mantling material of ash or cinder.

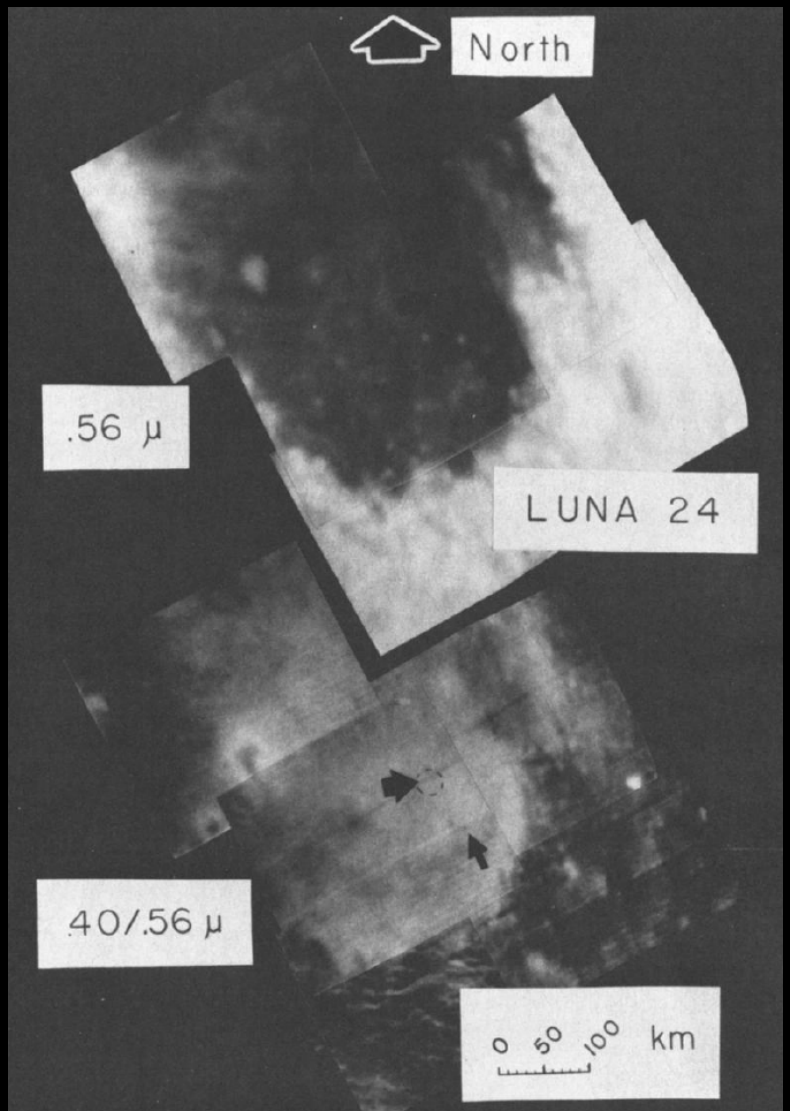
Series of papers:

- Pieters et al. 1973
  [submitted Dec. 1972]

- Pieters et al. 1976
- Barsukov et al., 1977
- Adams et al. 1978
- Head et al. 1978
- Pieters et al. 1979

Correct prediction, but for the wrong reason….

Lessons from incomplete data….



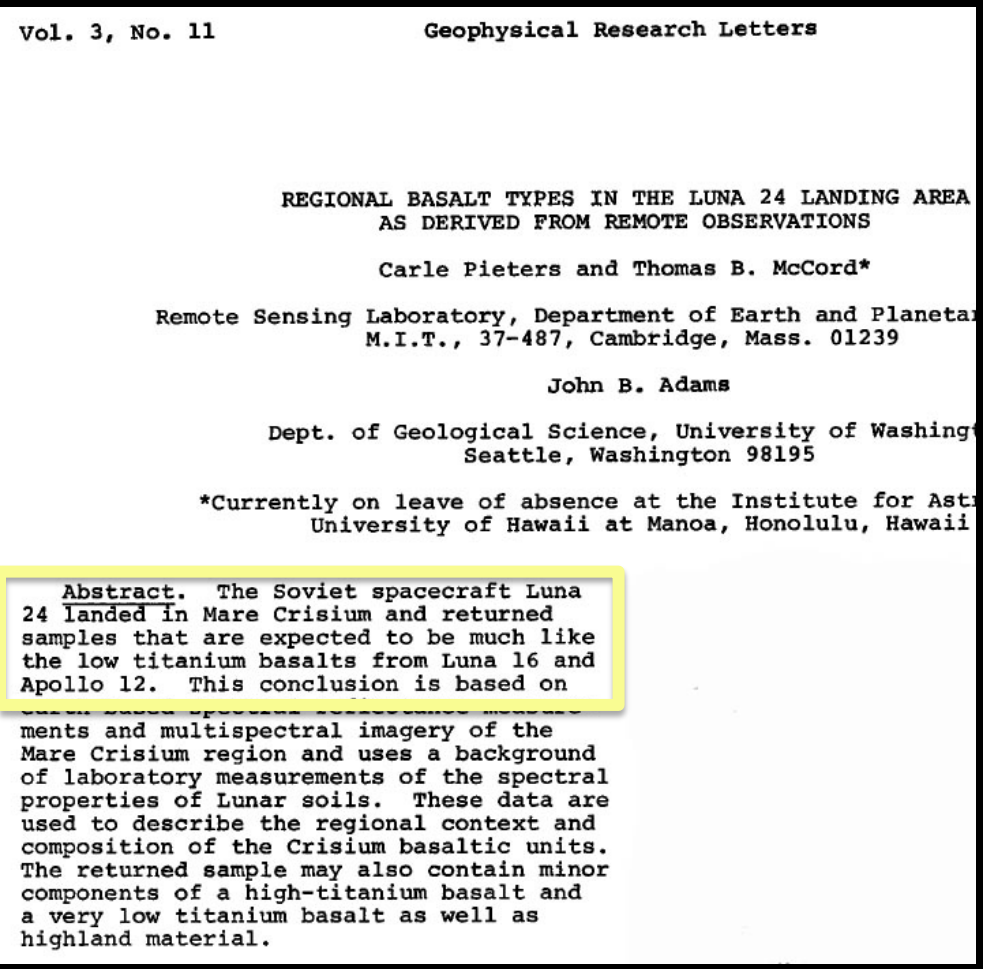
Series of papers:

- Ap17: Pieters et al. 1973 [submitted Dec. 1972]

Luna 24 landed Aug 1976

- Pieters et al. 1976
- Barsukov et al., 1977
- Adams et al. 1978
- Head et al. 1978
- Pieters et al. 1979

Lessons from incomplete data….



Vol. 3, No. 11 Geophysical Research Letters

REGIONAL BASALT TYPES IN THE LUNA 24 LANDING AREA AS DERIVED FROM REMOTE OBSERVATIONS

Carle Pieters and Thomas B. McCord*

Remote Sensing Laboratory, Department of Earth and Planetar
M.I.T., 37-487, Cambridge, Mass. 01239

John B. Adams

Dept. of Geological Science, University of Washing
Seattle, Washington 98195

*Currently on leave of absence at the Institute for Astr
University of Hawaii at Manoa, Honolulu, Hawaii

Abstract. The Soviet spacecraft Luna 24 landed in Mare Crisium and returned samples that are expected to be much like the low titanium basalts from Luna 16 and Apollo 12. This conclusion is based on

ments and multispectral imagery of the Mare Crisium region and uses a background of laboratory measurements of the spectral properties of Lunar soils. These data are used to describe the regional context and composition of the Crisium basaltic units. The returned sample may also contain minor components of a high-titanium basalt and a very low titanium basalt as well as highland material.

Series of papers:

- Pieters et al. 1973 [submitted Dec. 1972]

- Pieters et al. 1976 [sub Sept]
- Barsukov et al., 1977
- Adams et al. 1978
- Head et al. 1978
- Pieters et al. 1979

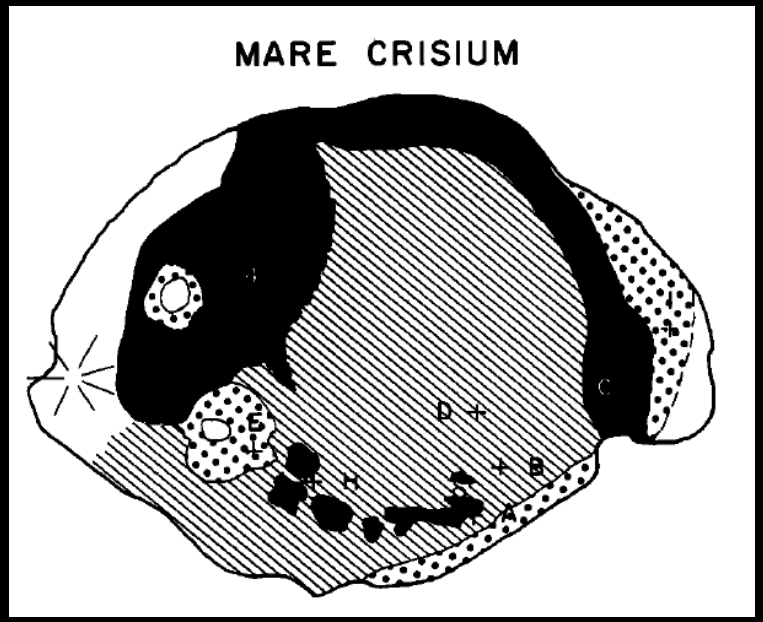
Lessons from incomplete data….

Luna 24 Sample Analyses:
- *Very **Low-Ti*** mare basalt
- All soils ***very immature***

Series of papers:
- Pieters et al. 1973
  [submitted Dec. 1972]

- Pieters et al. 1976
- Barsukov et al., 1977
- Adams et al. 1978
- Head et al. 1978
- Pieters et al. 1979

Lessons from incomplete data….

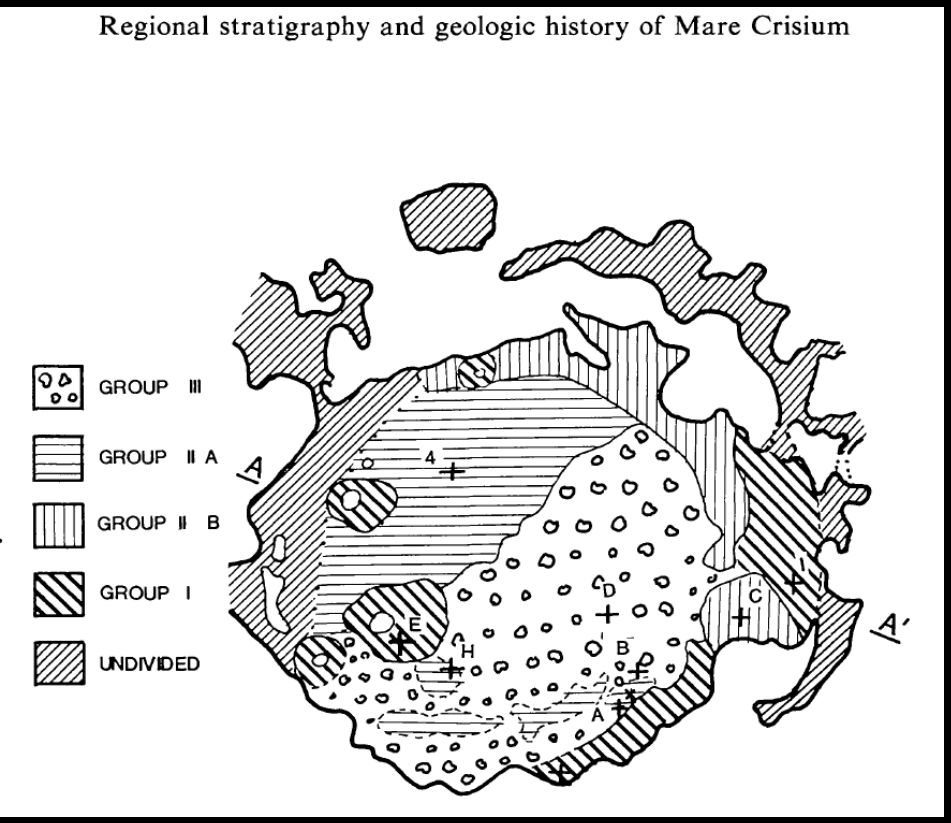


Series of papers:

- Pieters et al. 1973
  [submitted Dec. 1972]

- Pieters et al. 1976
- Barsukov et al., 1977
- Adams et al. 1978
- Head et al. 1978
- Pieters et al. 1979

Lessons from incomplete data….

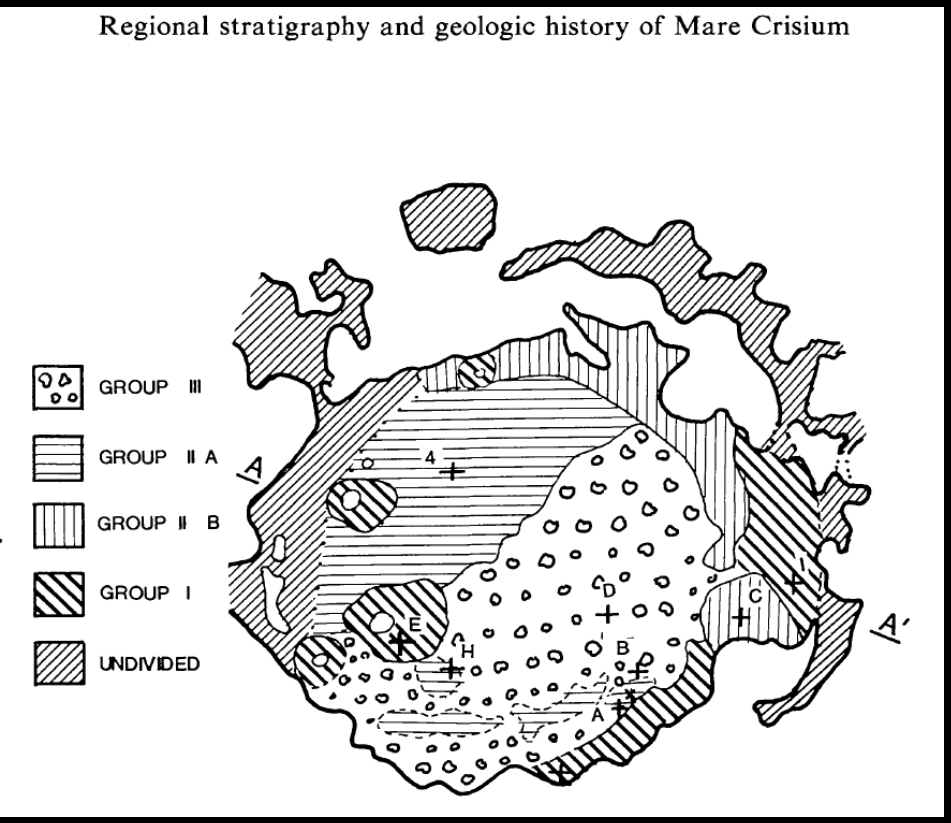


Series of papers:

- Pieters et al. 1973
  [submitted Dec. 1972]

- Pieters et al. 1976
- Barsukov et al., 1977
- Adams et al. 1978
- Head et al. 1978
- Pieters et al. 1979

Lessons from incomplete data….



Series of papers:

- Pieters et al. 1973
  [submitted Dec. 1972]

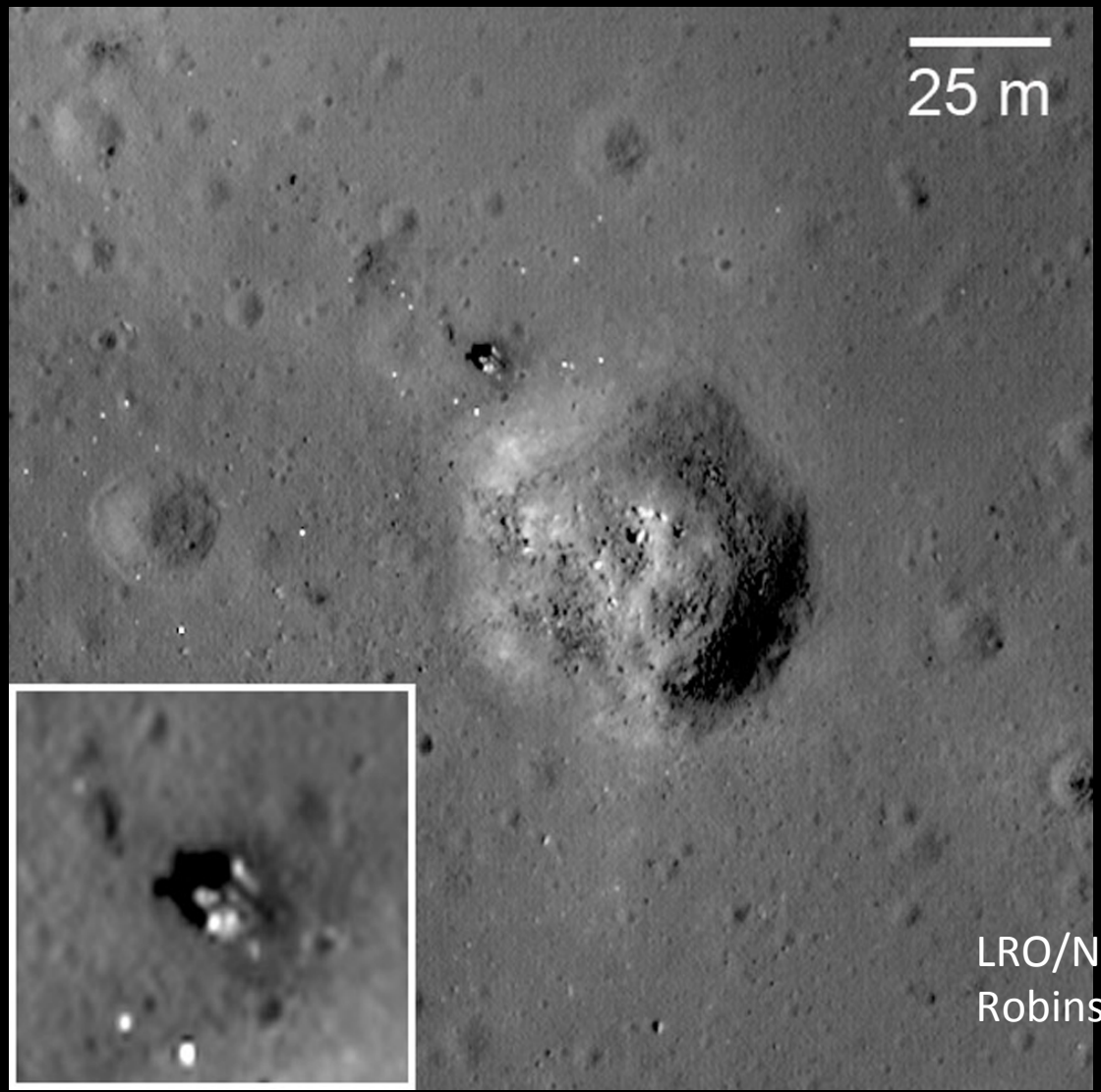
- Pieters et al. 1976
- Barsukov et al., 1977
- Adams et al. 1978
- Head et al. 1978
- Pieters et al. 1979

…….Plus many on TiO_2 issue

Luna 24 Basalts

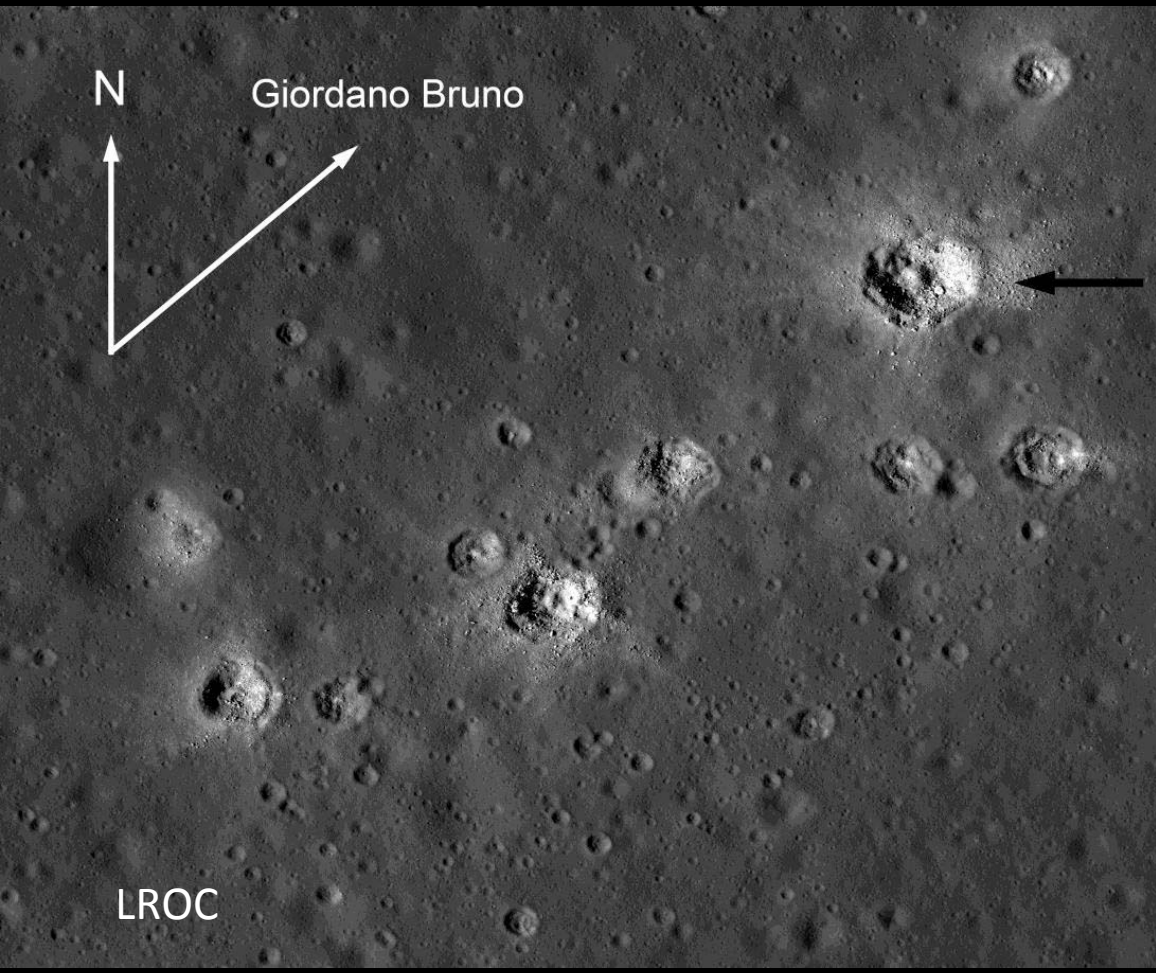
- The Luna 24 samples were the last to be returned from the Moon.
- They defined a major new class of basalt unsampled by Apollo (except for a few soil fragments).
  - Very Low-Ti basalt [<1% TiO2]
  - Low to Very Low maturity

40 years later……
Luna 24 in Mare Crisium



LRO/NAC
Robinson et al., 2012

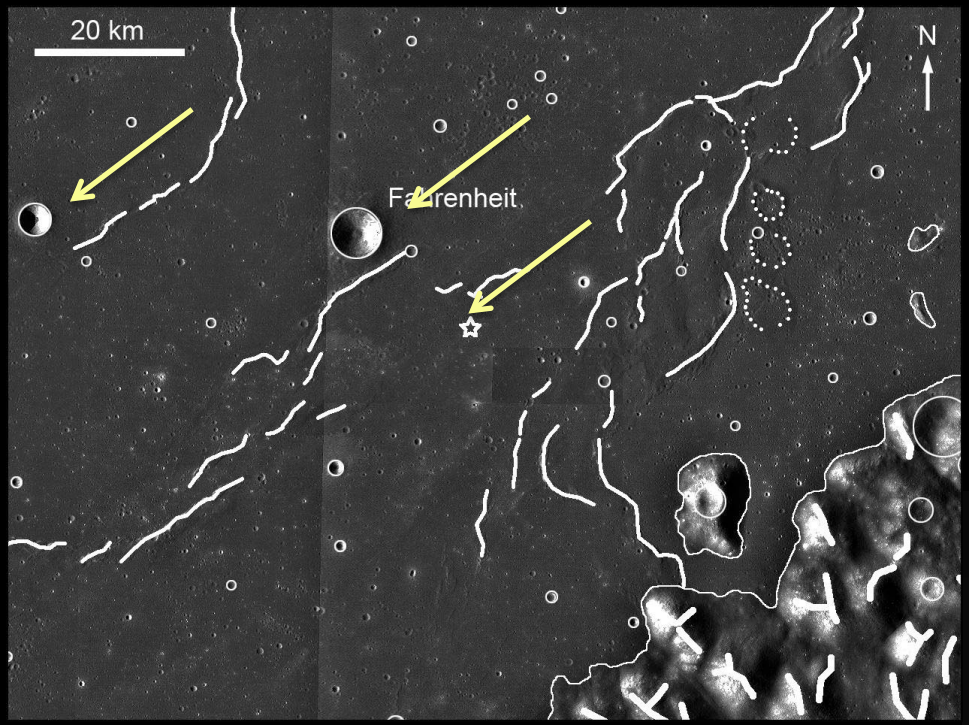
Luna 24 and Giordano Bruno Secondaries



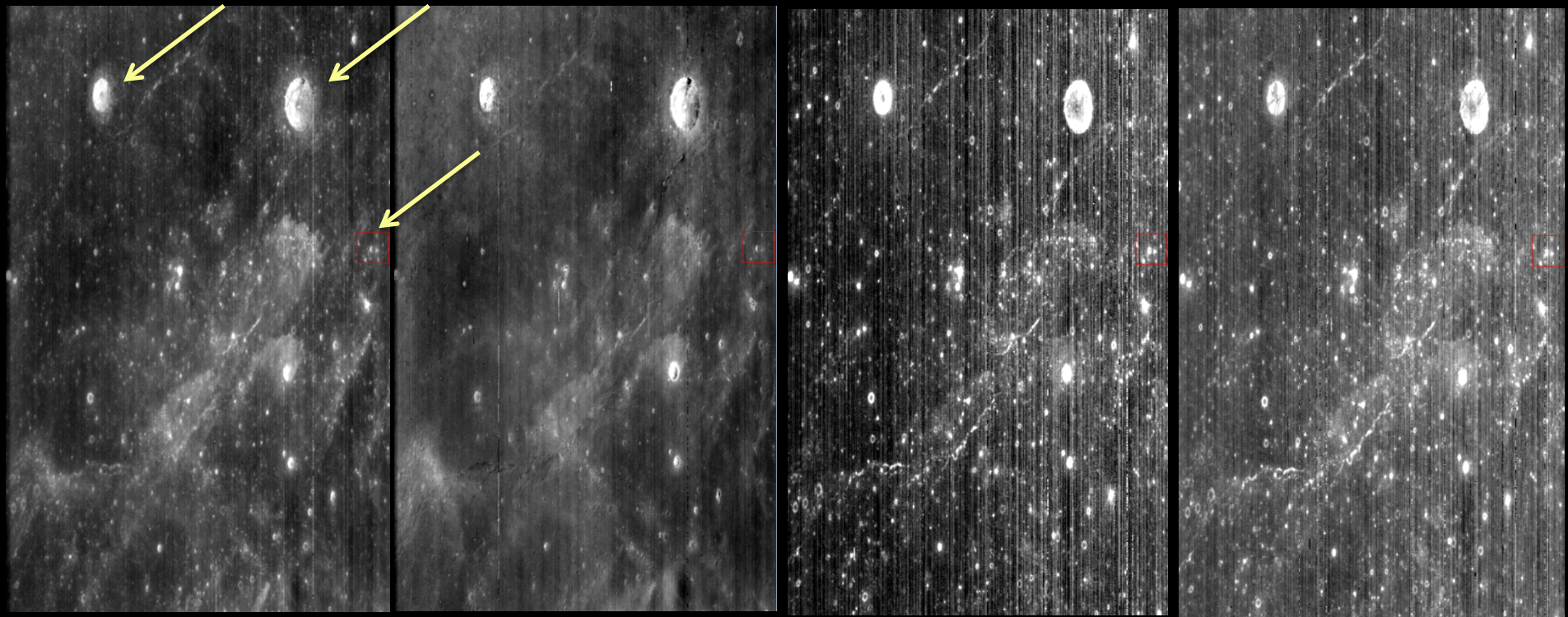
- L24 crater is one of many secondary craters in the area.
- Age estimates 1-10 My*
- Comparable to similar age estimates for Giordano Bruno*

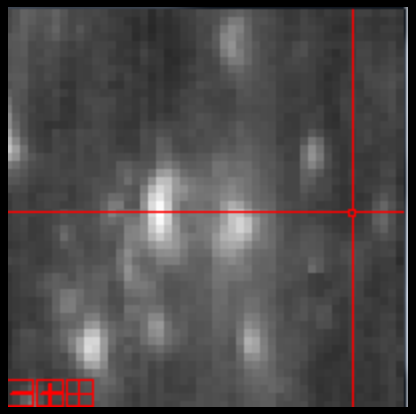
*Morota et al. 2010; Basilevsky, 2012 submitted

Regional Context



1484 nm 2971 nm IBD 1000 IBD 2000

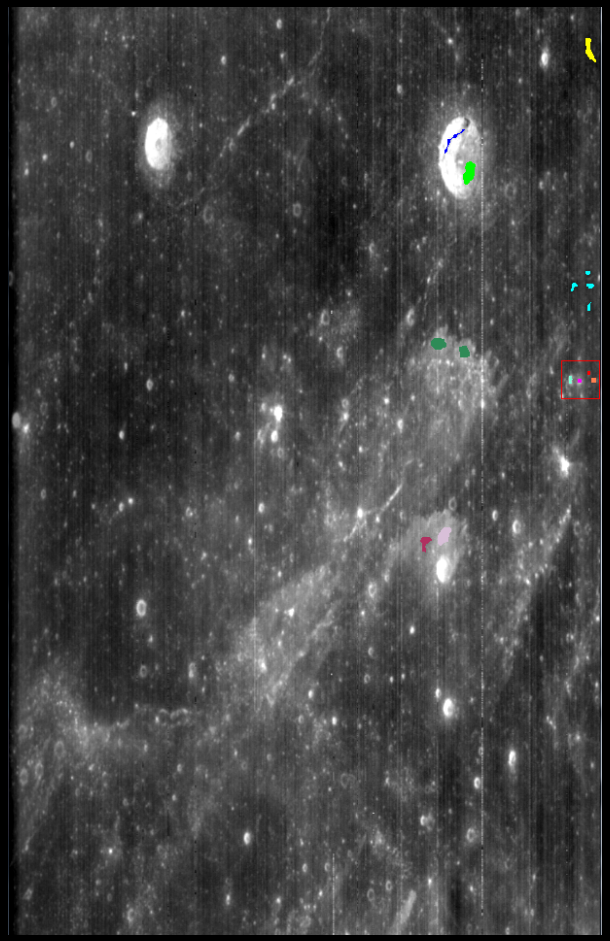


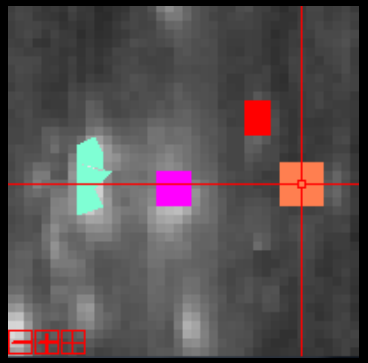


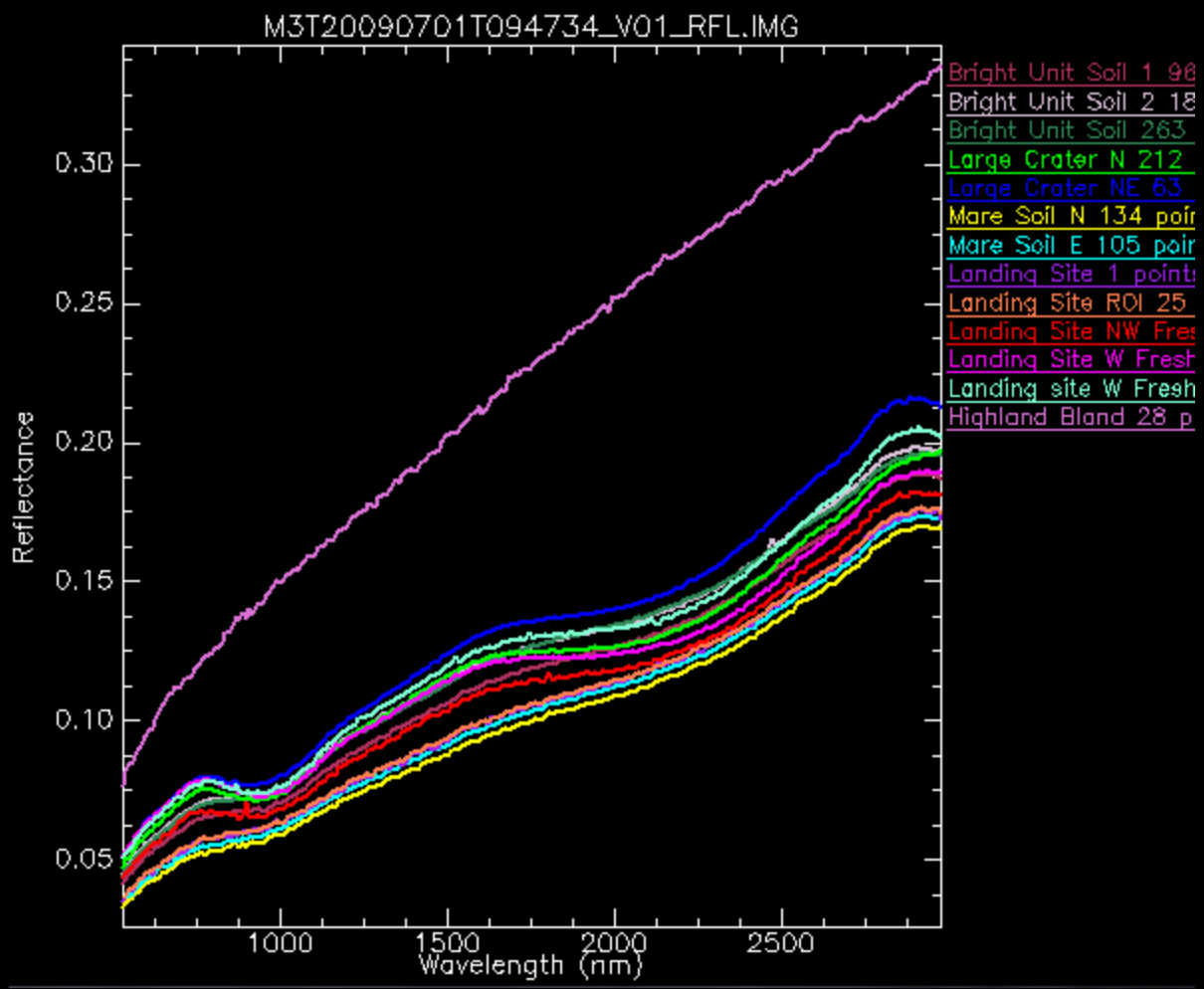
M3T20090701T094734

Luna 24: M3 Target Mode

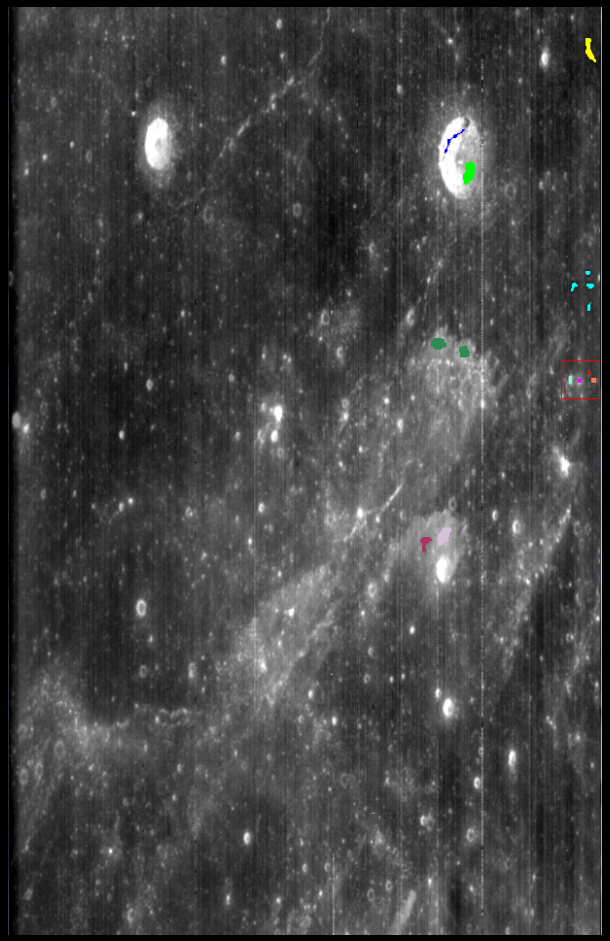
(70x140 m; 256 Bands)

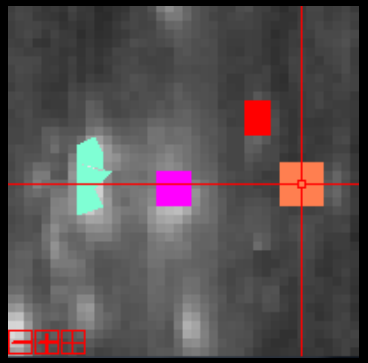


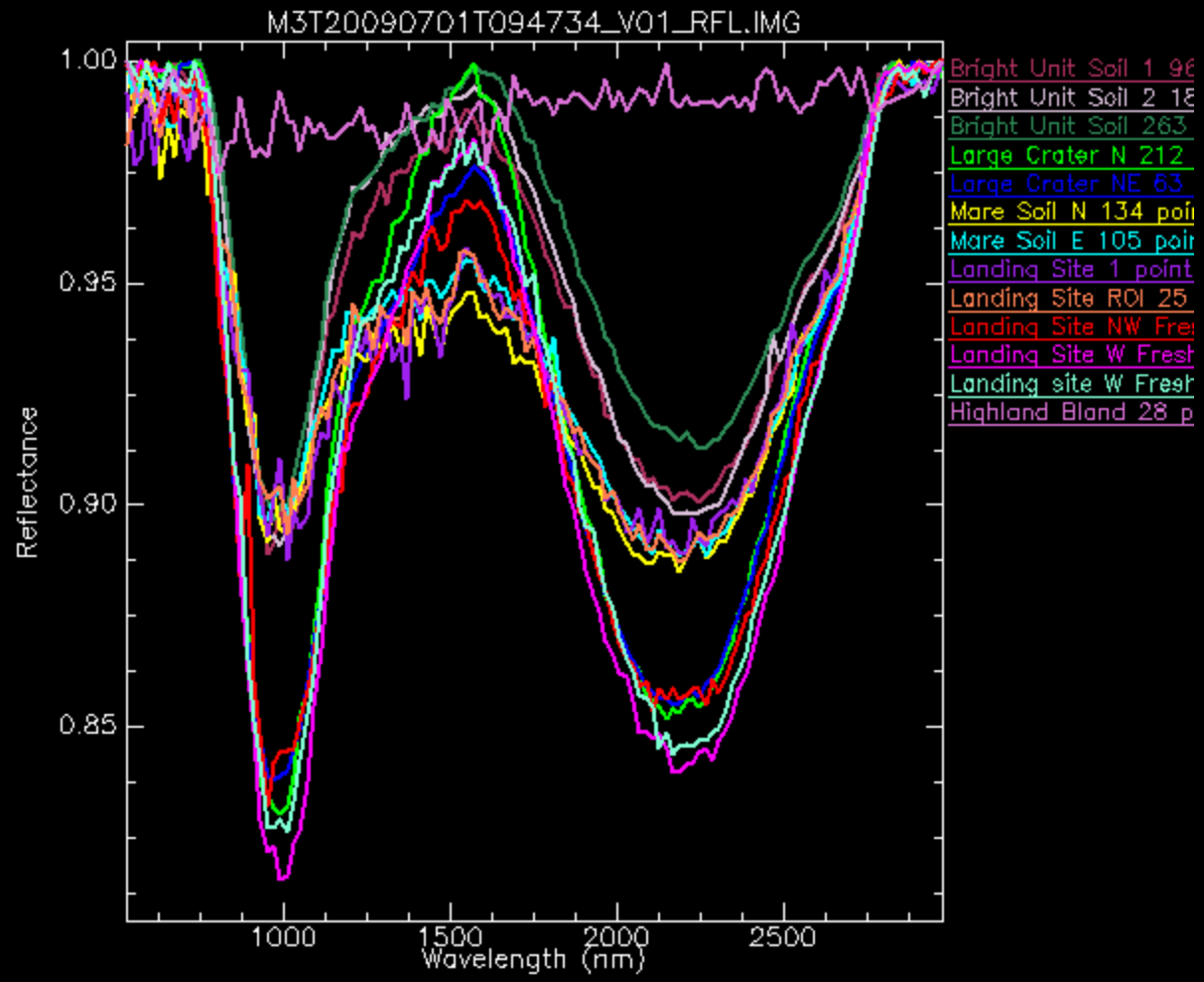




Representative Spectra of LUNA 24 Landing Site and Surroundings

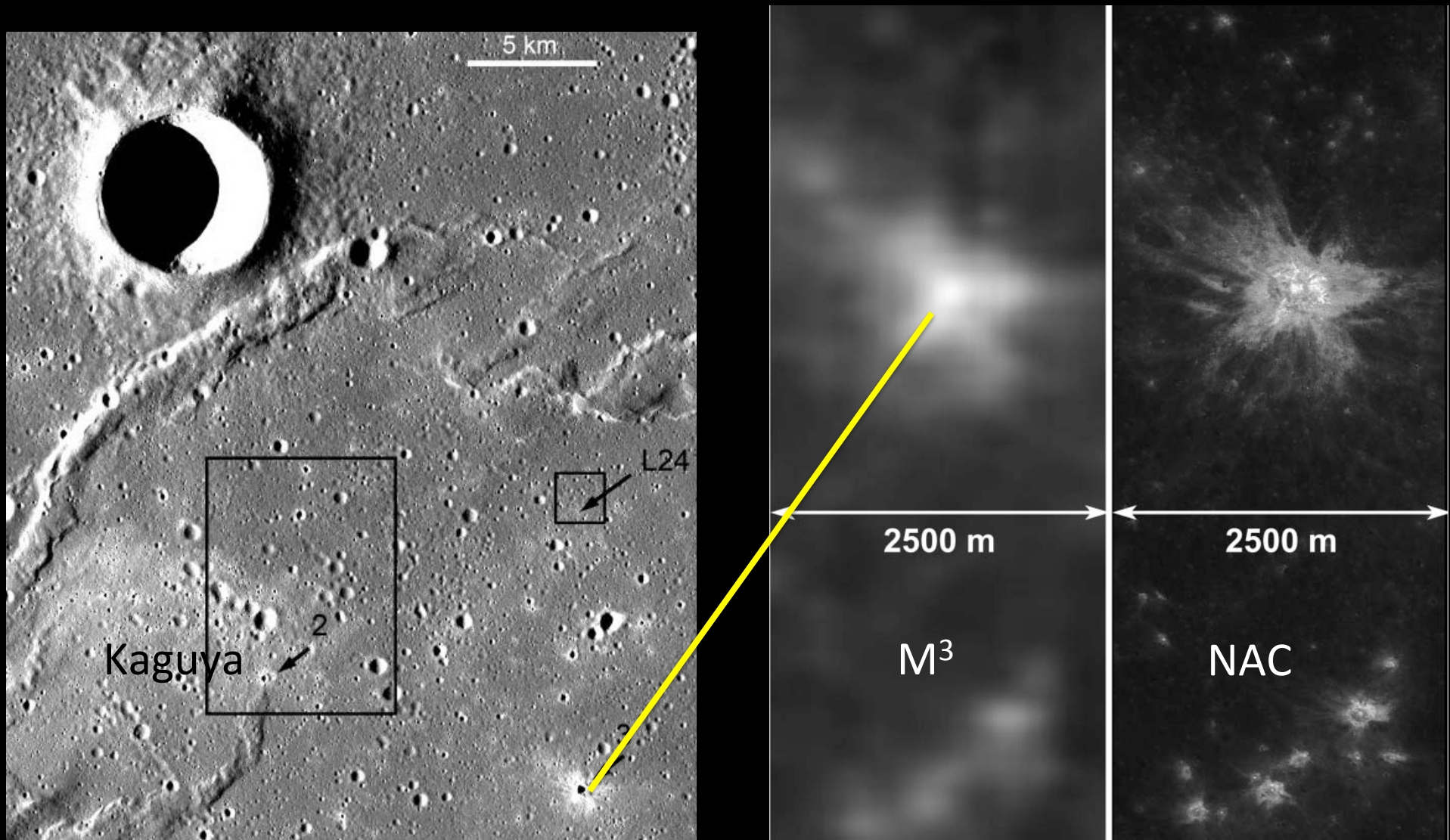




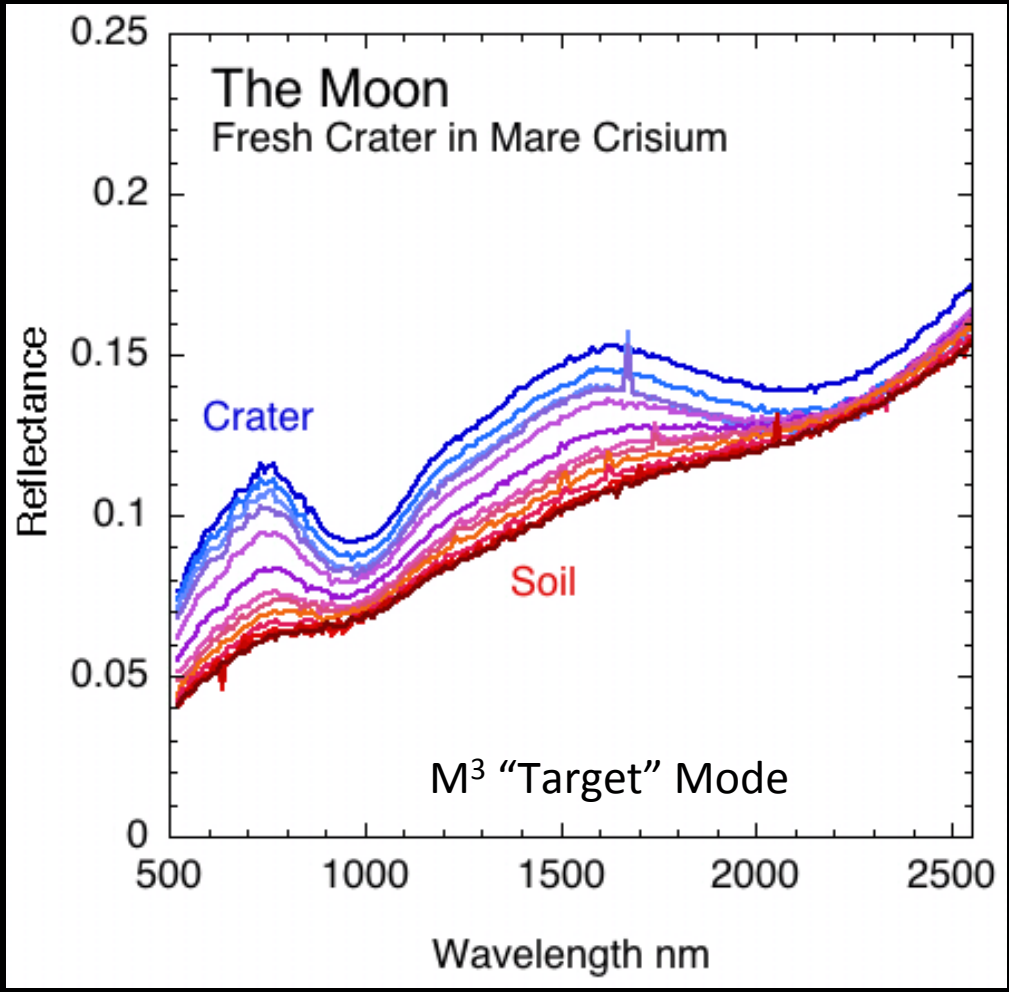


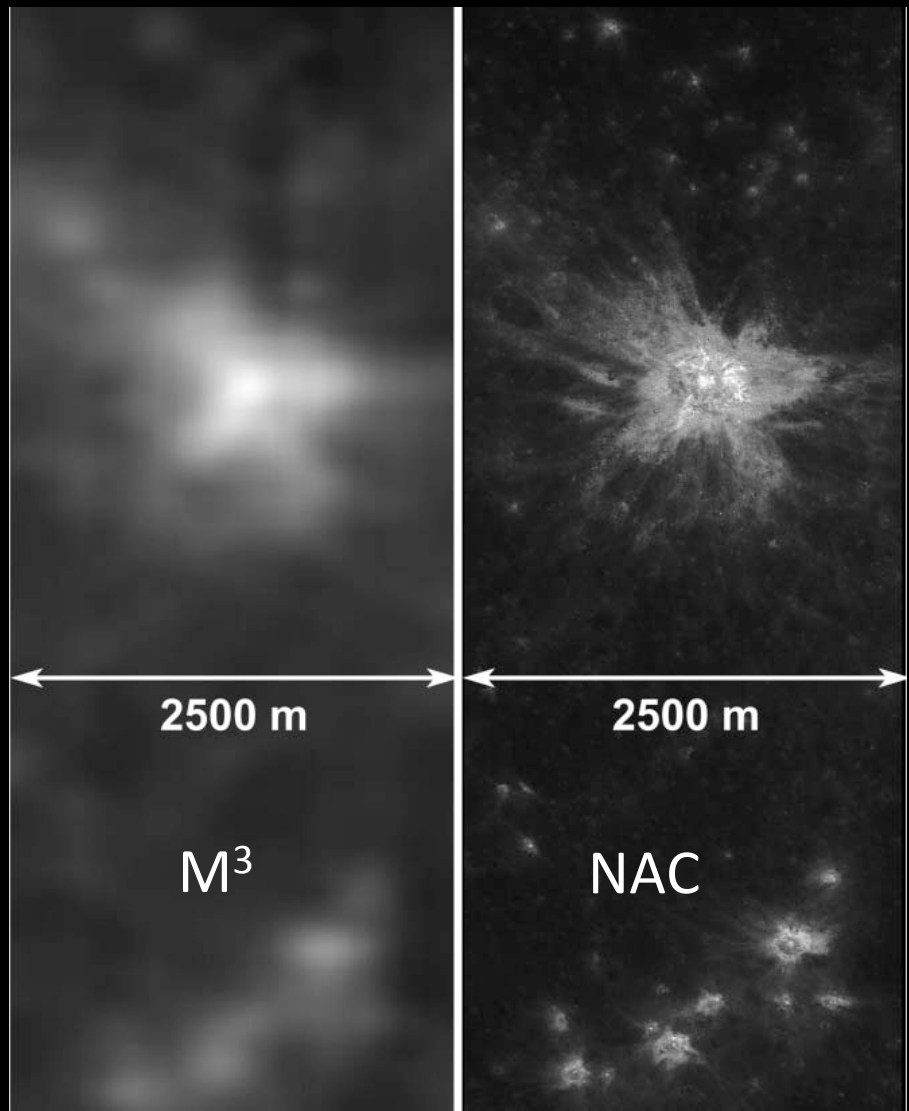
Representative Spectra of LUNA 24 Landing Site and Surroundings

Kaguya-M^3-NAC

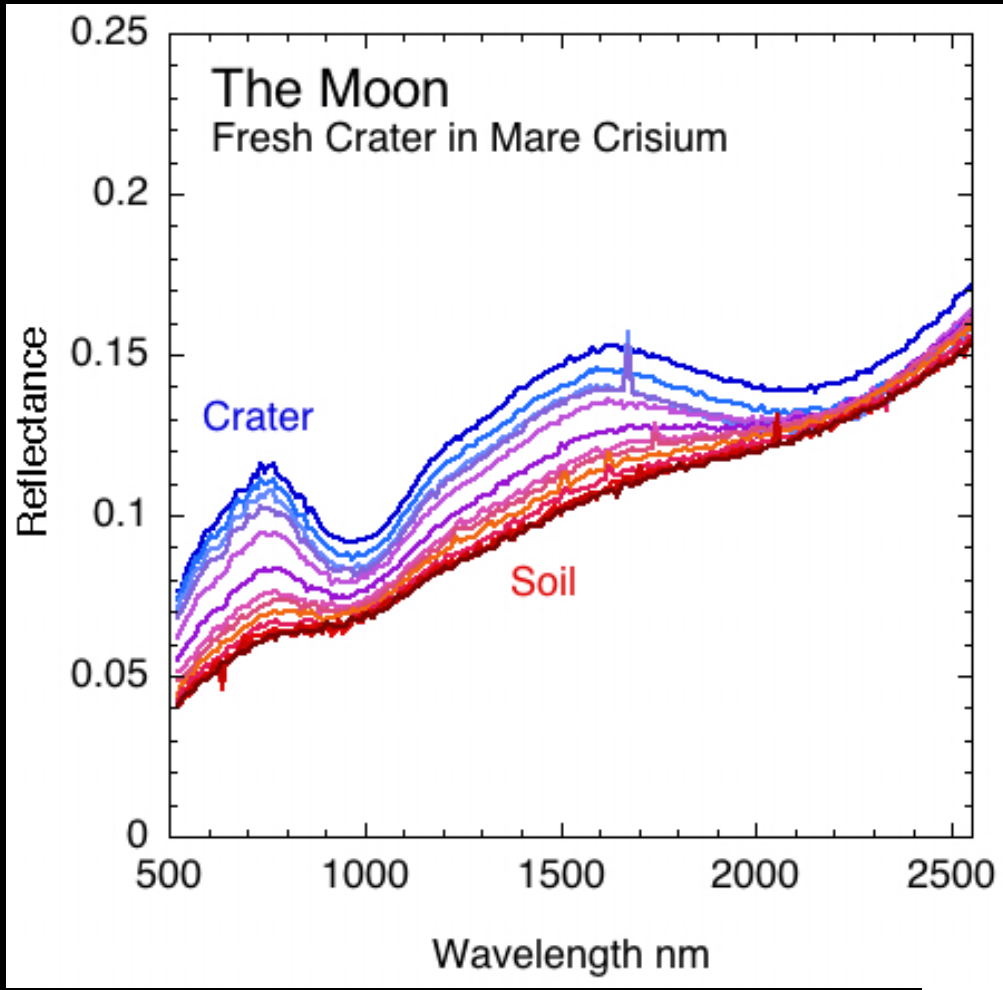


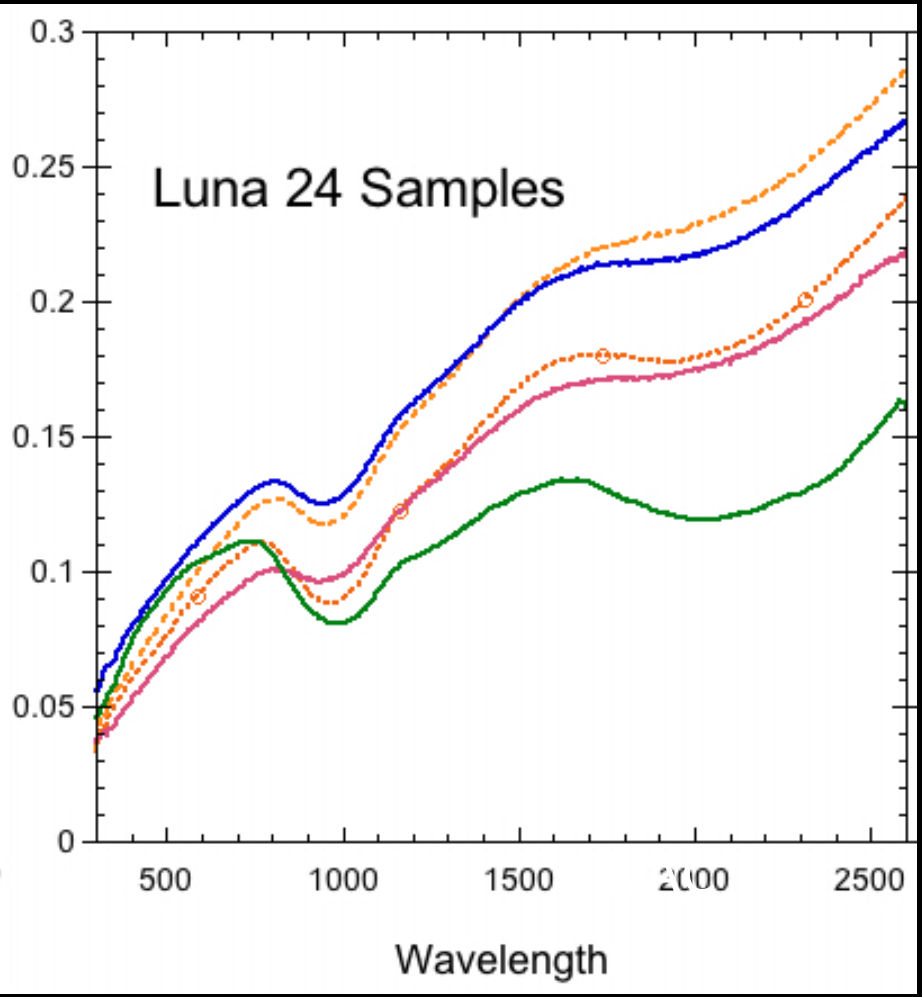
M^3 Spectra: Fresh Crater and Soil





M^3 Spectra and Luna 24 Soils





Summary: It *all* makes sense now.

- The enigma of Luna 24 samples (High FeO, very low-Ti, and immature) has been with us for decades.
- LRO/NAC data clarifies the geology:
  - The region is strewn with Giordano Bruno secondary craters.
  - Luna 24 sits on the rim of one such crater.
- New (M^3) spectra of the region are now fully consistent with sample spectra.